

ANL Capabilities for Hydrogen Storage:

Chemical Hydride Center (lead) & Carbon / Hydrides (contributor)

*DOE Hydrogen Storage Pre-Solicitation Meeting
June 19, 2003 - Washington, DC*

Argonne National Laboratory



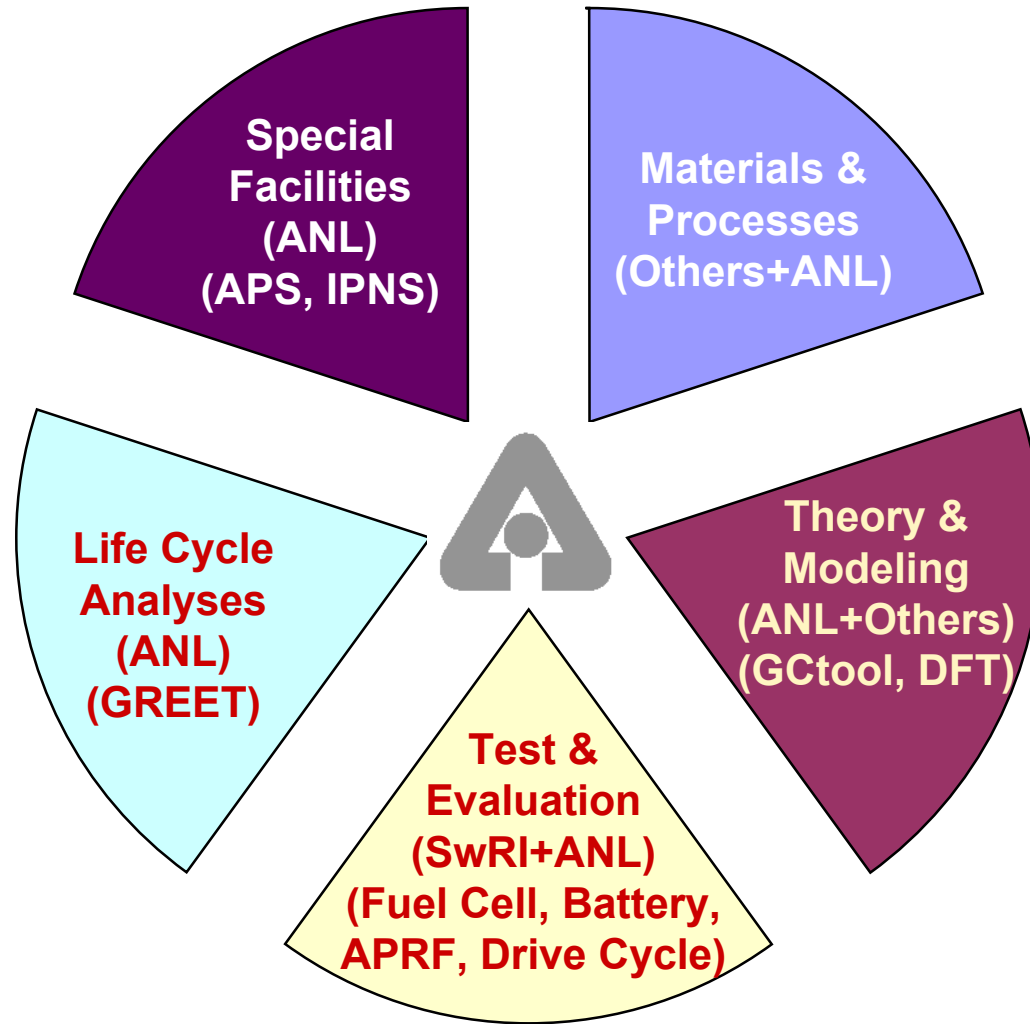
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Proposed Argonne role in H₂ storage materials and processes research

- **Lead laboratory for Chemical Hydrides Center**
 - ✓ Process definition and analysis / life-cycle analysis
 - ✓ Materials design (theory / modeling) and synthesis
 - ✓ In situ & ex situ characterization (X-ray, neutron scattering)
 - ✓ System-level hardware testing and validation
- **Participant in carbon-based and metallic H₂ storage materials and charging processes (e.g., electrochemical)**
 - ✓ Amorphous carbons, carbon monoliths, carbon molecular sieves, sepiolite-derived carbon, organometallics
 - ✓ Synthesis of low-Z, high interstitial complex metal hydrides, structural analyses (X-ray, neutron scattering, NMR)
 - ✓ Molecular modeling (H₂-matrix interaction, electronic structure, bonding)
 - ✓ System-level hardware testing and validation
- **Participant with industry / academia in individual Category 2 projects**
 - ✓ New/novel storage materials (cages, nanomaterials)
 - ✓ On-board compressed & liquid hydrogen storage (sensors)
 - ✓ Off-board hydrogen storage (materials & energy assessments)
 - ✓ Infrastructure/vehicle refueling (compressor materials & testing)

Argonne vision of the chemical hydride virtual center



ANL has strengths and capabilities in materials design, synthesis, and characterization

■ **Unique facilities**

- Advanced Photon Source (X-rays for materials studies)
- Intense Pulsed Neutron Source (especially for light elements)
- Electron Microscopy Center (TEM, SEM)
- Center for Nanoscale Materials

■ **Systems-level and life-cycle analyses**

- GREET (life-cycle analyses, regulated and GHG emissions)
- GCtool (systems design and analysis, optimization)

■ **Molecular dynamics modeling for tailored materials**

- H₂ interaction with host matrix materials

■ **Materials synthesis, fabrication, and characterization**

- Metals, ceramics, cermets, carbons
- AFM, MRI, Raman – FTIR, quantitative mass spec, etc.

■ **Battery & fuel cell component- and system-level testing**

Argonne's expertise relevant to H₂ storage materials and process development

- **Advanced battery materials and concepts**
 - Amorphous carbon with surface cavities [ANL work with C-Li compounds with high Li capacities (equiv to 12-14 wt% H₂)]
- **Structural analysis by X-ray absorption spectroscopy of model materials (e.g., alanates) in situ / ex situ**
 - Correlate structure with simultaneous hydrogen sorption / desorption and calorimetry measurements
- **Influence of type of on-board hydrogen storage on automotive fuel cell system performance and fuel economy**
 - GCtool simulation of compressed H₂, low- and high-temperature hydrides, glass microspheres, steam-sponge iron, etc. (published in CCM and ECS proceedings)
 - Optimum integration of the hydrogen storage subsystem with the fuel cell (or ICE) power plant

Collaboration and teamwork are our hallmark!

Two Examples

- **Fast-start fuel processor (FASTER) project**
 - ✓ National Laboratories: LANL, ORNL, PNNL, ANL (lead)
 - ✓ Industry: Precision Combustion, Arvin-Meritor, Quantum
 - ✓ Universities: Purdue-Calumet, Illinois Institute of Technology
 - ✓ Intellectual property agreements
 - ✓ Mission-driven; focused on meeting DOE targets
- **Battery Advanced Technology Development (ATD) project**
 - ✓ Multiple Laboratories: LBNL, BNL, SNL, INEEL, ANL (lead)
 - ✓ Universities: Wisconsin, Illinois, IIT
 - ✓ Industry: Quallion, others
 - ✓ Coordinated, integrated program for DOE